

Selection of 33% RES Portfolios for Economic Modeling

CARB Workshop

April 5, 2010



Energy and Environmental Economics, Inc.

Arne Olson, Partner

Agenda

- Overview
 - 33% RES Calculator
 - Plausible Compliance Scenarios
 - Planned model updates
- RES Calculator Inputs and Methodologies
 - Resource gap calculation
 - Sources of renewable resource availability, cost and performance data
 - Methodology for selecting portfolios of renewable resources
 - Methodology for calculating ratepayer cost impacts
- Draft Results from Current Working Model

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About E3



E3's expertise has placed us at the nexus of planning, policy and markets in California and the West

Regulatory/Policy

- EE avoided costs for CA utilities
- Calculate MPR for CPUC
- 33% RPS and GHG studies for CPUC
- Advising CPUC on long-term planning
- CA Solar Initiative cost-effectiveness
- EPA National Action Plan for efficiency
- 2007 Idaho Energy Plan

Utility

- WEIL Group "Towards 2020" study of renewables and transmission in West
- BC-California renewable energy partnership
- Advising PG&E on Diablo relicense
- Assisting HECO with Feed-in Tariff
- Expert testimony for CAISO on Sunrise line
- Capital cost model for TEPPC 2009 Study

Cleantech/Emerging Technologies

- Analysis of market opportunities for emerging technologies such as renewables, distributed generation, smart grid, energy storage, plug-in hybrid vehicles, demand response
- Clients include EPRI, BrightSource, First Solar, Hydrogen Energy International, VC clients

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Overview

33% RES Calculator

- CARB 33% RES economic modeling will rely on 33% RES Calculator
 - Spreadsheet model developed by E3 for CPUC's June 2009 "33% RPS Implementation Analysis" report
- Model generates plausible resource portfolios for serving California load in 2020 under 20% and 33% renewables requirements
- Model was updated in October 2009 to generate new portfolios for CAISO's 33% RPS Operational Study
- Additional updates planned for 33% RES rulemaking



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33% RES Plausible Compliance Scenarios

- ARB has identified two "plausible compliance scenarios" to explore the effects of different assumptions about demand-side programs on a 33% RES
 1. **High Net Short:** 2020 load from CEC 2009 IEPR forecast; no additional demand-side load reductions achieved
 2. **Low Net Short:** The state implements a portfolio of demand-side measures (efficiency, DG, CHP, etc.) to reduce the rate of load growth well below the 2009 IEPR forecast
- Results will be built from CPUC's "33% RPS Reference Case" with updated net loads
- Outputs from RES Calculator used in EDRAM Macroeconomic modeling

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Updates to Inputs and Assumptions Since June 2009 Public Version

- Updated forecast of net load based on ARB Plausible Scenarios
- Change in methodology for adding fossil resources
 - Specified near-term gas-fired resources for all cases
 - Increased OTC plant retirements based on State Water Resources Control Board June 2009 draft ruling
 - Slight change in methodology for adding generic CCGTs and CTs
- Reduced wind capacity credit based on most recent NQC values
- Reduced solar PV costs based on new information (base cost reduced from \$7065 to \$4500/kW)
- Updated gas price forecast
- Removed assumptions regarding CO2 allowances

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Planned Updates for ARB 33% RES Rulemaking

- **Emissions:** Calculate statewide emissions of criteria pollutants and other toxic emissions
- **Renewable Energy Certificates (RECs):** Modify the RES Calculator to permit analysis of various out-of-state REC scenarios
- **Small Load-Serving Entities (LSEs):** Add ability to model exclusion of smaller LSEs from compliance
- **Cost of Demand-Side Programs:** Add utility cost and customer cost estimates for incremental demand-side programs in Low Net Load case



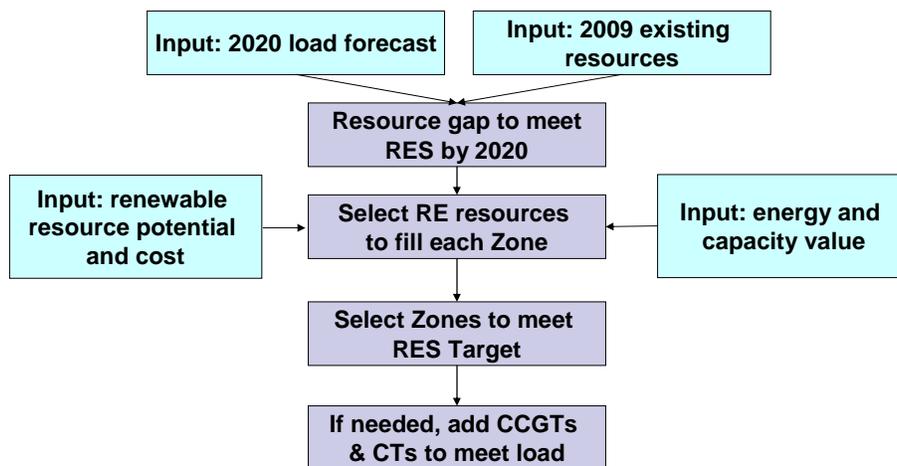
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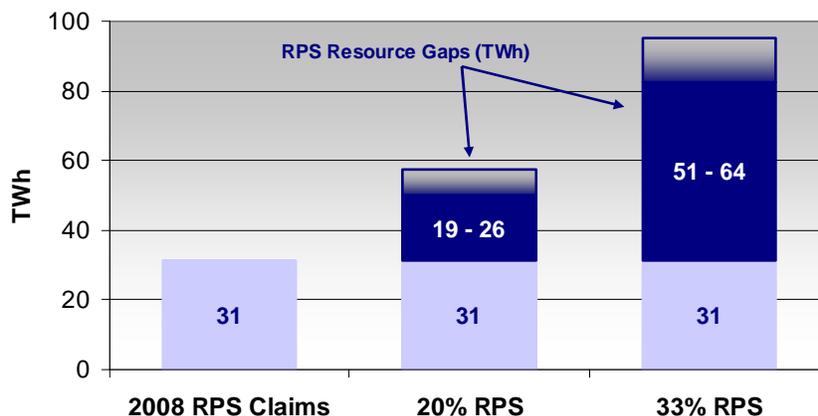
RES Calculator Inputs and Methodologies

Portfolio Development Process



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2008 Claimed RPS Resources for California Utilities and 2020 RPS Resource Gaps



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Details of ARB Plausible Scenarios

- Load modifiers developed by California energy agencies (CEC, CPUC, CARB, CAISO) in October 2009 to develop a unified set of cases that the agencies could use for planning purposes
- Incorporates 2009 CEC IEPR load forecast plus additional modifiers for EE, PV, & CHP
- RPS Calculator updated in October 2009 for use in CAISO Operational Study

2020 California Load and Load Modifiers for CPUC and CARB Cases

California Retail Sales (GWh)	June 2009 CPUC 33% RPS Implementation Analysis Report		2010 CARB 33% RES Plausible Scenarios	
	33% RPS Reference Case	Low-Load Sensitivity	High Net Short	Low Net Short
2008 Retail Sales	277,479	277,479	274,746	274,746
2020 Retail Sales	320,519	320,519	301,385	301,385
Incremental Energy Efficiency	-	(18,920)	-	(22,304)
Incremental Solar PV/DG	-	(3,129)	-	(1,885)
Incremental behind-the-meter CHP	-	(9,768)	-	(14,031)
Total Behind-the-Meter Adjustments	-	(31,817)	-	(38,220)
Water Agencies	(12,299)	(12,299)	(13,556)	(13,556)
Retail Sales Required to Meet 33% RES	308,220	276,404	287,829	249,609
33% RPS Requirements	101,713	91,213	94,983	82,371
2008 Existing Renewables	27,063	27,063	31,272	31,272
2020 Net Short Position for Renewables	74,650	64,150	63,711	51,099

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Four Sources of New Resources to Fill Resource Gap

1. CPUC Energy Division Project Database
 - Contracted or short-listed utility projects
 - CPUC ratings of project viability
2. Renewable Energy Transmission Initiative (RETI)
 - Pre-identified and proxy projects for California and BC
3. E3 GHG Calculator
 - Estimates of renewable resource availability by resource class for out-of-state regions
4. E3/B&V estimates of renewable DG resource potential



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CPUC Energy Division Project Database

- Database of renewable projects contracted or short-listed by an IOU
- Each project is assigned to a Zone
- Categorize projects based on status and CPUC ratings of development risk:
 - Category A: Contract approved and low or medium risk
 - Category B: Short-listed or pending approval and low or medium risk
 - Category C: All projects rated "high risk"
- Category A and B projects treated as "sunk costs" for ranking purposes
 - Improves ranking of zone
 - Projects not selected for portfolio unless Zone is selected

Capacity (MW)	Category A	Category B	Category C	Total
Biogas	10	-	20	30
Biomass	75	258	74	407
Geothermal	398	120	-	459
Hydro - Small	22	19	-	40
Solar PV	16	3,623	-	3,639
Solar Thermal	554	6,942	1,312	8,807
Wind	2,440	3,069	83	5,592
Total	3,455	14,029	1,488	18,973

Energy (GWh)	Category A	Category B	Category C	Total
Biogas	157	-	163	320
Biomass	559	1,539	611	2,709
Geothermal	1,934	998	-	2,931
Hydro - Small	68	58	-	126
Solar PV	34	7,740	-	7,774
Solar Thermal	1,388	18,322	5,097	24,807
Wind	7,550	10,476	256	18,282
Total	11,690	39,132	6,127	56,948

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Renewable Energy Transmission Initiative Phase 1B

- Black & Veatch estimates of resource availability, cost and performance
 - Combination of “Pre-Identified” and “Proxy” projects
 - Geothermal and Biomass resources estimated as distinct projects
 - Solar thermal and wind resources estimated by area
- RETI database includes site-specific cost estimates
 - Incorporated into 33% RES model via adjustments to a “generic” resource
- Used for California, Mexico and some BC resources

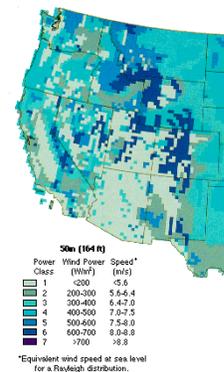
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Out of State Renewable Resource Data from E3 GHG Calculator

- E3 developed renewable resource cost and performance data throughout the WECC for use in 2007 “GHG Calculator”
 - Wind and solar data from National Renewable Energy Laboratory
 - Geothermal and hydro data from US Energy Information Administration
 - Biomass aggregated from various sources
 - Additional resource data for BC and Alberta
- For 33% RES Calculator, E3 data is used for regions outside of California



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E3-B&V Estimates of DG Potential

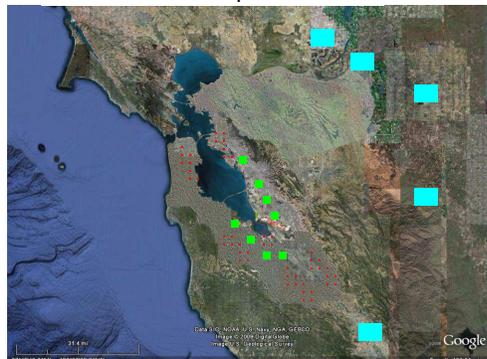
- Distributed generation (DG) is small-scale generation interconnected at sub-transmission system or lower
- Rule 21 sets DG interconnection limit at 15% of peak load on a feeder
 - Relaxed to 30% based on assumption that most DG is PV
- E3 and B&V conducted a feeder-by-feeder analysis of small PV potential matched to substation loading

Results:

- 6077 MW of ground-mounted or large rooftop PV in urban areas
- 9000 MW of ground-mounted PV near rural substations (not Rule 21 compliant)

Illustrative Example of Distributed Solar PV

- 20 MW near substations
- Large commercial rooftops
- Residential rooftops



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Additional Zones for Distributed and non-CREZ Resources

- Model logic selects individual resources to fill Zones, then selects Zones to meet RES target
- Created Zones for bundles of resources assumed deliverable over existing transmission:
 - Distributed Biogas, Distributed Biomass, Distributed Geothermal, Distributed Hydro, Distributed Solar, Distributed Wind, Remote DG
 - "Out-of-State Early": 2062 MW of ED Database projects located in other states
 - "Out-of-State Late": 1925 MW of ED Database and generic projects located in other states



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List of Renewable Energy Zones in 33% RES Analysis

- | | | |
|-------------------------------|------------------------|------------------------------|
| 1. Alberta | 18. Imperial North | 35. Pisgah |
| 2. Arizona-Southern Nevada | 19. Imperial South | 36. Remote DG |
| 3. Baja | 20. Inyokern | 37. Reno Area/Dixie Valley |
| 4. Barstow | 21. Iron Mountain | 38. Riverside East |
| 5. British Columbia | 22. Kramer | 39. Round Mountain |
| 6. Carrizo North | 23. Lassen North | 40. San Bernardino - Baker |
| 7. Carrizo South | 24. Lassen South | 41. San Bernardino - Lucerne |
| 8. Colorado | 25. Montana | 42. San Diego North Central |
| 9. Cuyama | 26. Mountain Pass | 43. San Diego South |
| 10. Distributed Biogas | 27. Needles | 44. Santa Barbara |
| 11. Distributed Biomass | 28. NE Nevada | 45. Solano |
| 12. Distributed CPUC Database | 29. New Mexico | 46. South Central Nevada |
| 13. Distributed Geothermal | 30. Northwest | 47. Tehachapi |
| 14. Distributed Solar | 31. Owens Valley | 48. Twentynine Palms |
| 15. Distributed Wind | 32. Out-of-State Early | 49. Utah-Southern Idaho |
| 16. Fairmont | 33. Out-of-State Late | 50. Victorville |
| 17. Imperial East | 34. Palm Springs | 51. Wyoming |

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Renewable Resource Capital Cost Assumptions

- Capital cost assumptions for “generic” resource based on average of RETI sites
- Retained RETI’s site-specific cost information
- Supplemented with other data sources

Cost and Operating Assumptions for “Generic” Resources

	Biogas	Biomass	Geo-thermal	Hydro - Small	Solar PV	Solar Thermal	Wind	Gas CCGT
Operating Data								
Nominal heat rate	11,566	14,749						6,924
Capacity factor	85%	80%	87%	50%	25%	28%	33%	92%
Availability on-peak (% of nameplate)	100%	100%	100%	65%	51%	77-85%	11-20%	100%
Costs (California)								
Installed Capital Costs (\$/kW)	\$ 3,483	\$ 4,951	\$ 4,576	\$ 3,636	\$ 4,500	\$ 4,924	\$ 2,491	\$ 1,249
Variable O&M (\$/MWh)	\$ 0.01	\$ 11.06	\$ 29.99	\$ 3.30				\$ 4.92
Fixed O&M (\$/kW-yr)	\$ 108	\$ 82	\$ 159	\$ 13	\$ 50	\$ 58	\$ 53	\$ 11
Fuel Cost (\$/MWh)	\$ 24	\$ 45						\$ 68
Source	E3 GHG	RETI	RETI	E3 GHG	E3/TEPPC	RETI	RETI	MPR

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Financing Assumptions

■ Assume IPP resource financing

- 60% debt, 40% equity financing structure
- 15.3% cost of equity, 7.3% cost of debt (based on 3/08 Board of Equalization study)
- 20-year PPA at flat nominal prices



■ Different financing for solar projects

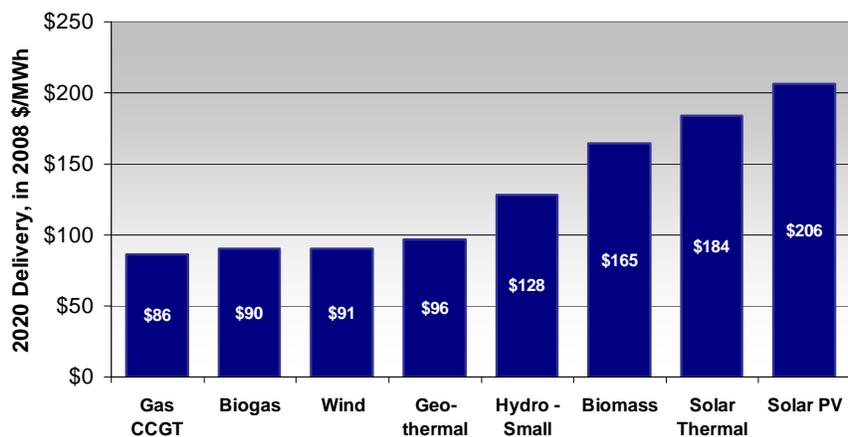
- 45% debt, 55% equity – More equity needed to maintain debt service coverage ratios above 1.5
- 13.25% cost of equity – Lower cost of equity to reflect reduced leverage

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Levelized Cost of Energy for "Generic" Resources



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Project Ranking: Modified RETI Ranking Methodology

- Steps for selecting resources

1. Rank projects within each Zone
2. Select projects to fill fixed-size transmission line
3. Rank and select zones to meet RES target

- ED Database projects automatically float to top of ranking

Project Ranking Formula

- + Levelized cost of energy
- + Interconnection (gen-tie) costs
- + Deemed integration costs
- + Levelized, per-MWh incremental transmission costs
- Energy value
- Capacity value
- T&D avoided costs
- Adjustment for ED RPS Projects
- ± Environmental score
- = Final project rank

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Once-Through Cooling Retirements

- Study assumes retirement of 16,178 MW of plants using once-through cooling by 2020

- Two plants assumed repowered or retrofit on site (1,183 MW)

- Capital cost added to 2020 revenue requirement in all cases

- Others replaced as needed depending on load-resource balance

Generator Name	Total Nameplate Capacity (MW)	Retired Capacity (MW)	Repower or Retrofit Capacity (MW)	Retirement Year
Alamitos 1&2	350	350		2020
Alamitos 3&4	668	668		2020
Alamitos 5&6	992	992		2020
Contra Costa	680	680		2017
El Segundo 3&4	670	670		2015
Encina 1-5	929	550		2017
Harbor	240	240		2017
Haynes 1&2	444	444		2015
Haynes 3&4	444	444		2015
Haynes 5&6	682	682		2015
Haynes 9&10	575			
Humboldt Bay	105	105	163	2011
Huntington	880	880		2020
Mandalay	430	430		2020
Morro	673	673		2015
Moss 1-4	1,020	1,020	1,020	2017
Moss 6&7	1,510	1,510		2017
Ormond	1,516	1,516		2020
Pittsburg	1,311	1,311		2017
Portrero	207	207		2011
Redondo 5&6	350	350		2020
Redondo 7&8	963	963		2020
Scattergood	803	803		2017
South Bay	690	690		2012
Total	17,132	16,178	1,183	

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New Fossil Resources

- Study also assumes addition of 5,325 MW of specified fossil generation capacity
- Fixed costs of these resources are included in the 2020 revenue requirement
- Model selects a combination of generic CCGTs and CTs to meet any remaining energy and capacity gaps

Specified Fossil Generation (based on CEC database)

Generator Name	Plant Type	Total Nameplate Capacity (MW)
Gateway - PG&E	CCGT	530
Inland Empire - GE	CCGT	400
Russell City CCGT	CCGT	600
Colusa Generation Station	CCGT	660
Otay Mesa - Calpine	CCGT	590
El Segundo Repower	CCGT	530
EIF Panoche - Energy Investors Fund	CT	400
Starwood Midway - Starwood Power	CT	120
Sentinel CTs	CT	850
Walnut Creek CTs	CT	500
SCE Peaker	CT	49
Orange Grove AFC = J Power USA	CT	96
Total Specified Additions		5,325

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Calculating Ratepayer Impacts

- Cost impact of 33% RES to electric ratepayers is equal to:

2020 statewide revenue requirement under the 33% RES case

MINUS

2020 statewide revenue requirement under current statute (20% RPS)

2020 Revenue Requirement

- + Existing T&D cost
- + New T&D caused by organic growth
- + Fixed & variable costs of existing Gen.
- + Annualized cost of new renewables
- + Renewables integration costs
- + Annualized cost of new transmission for renewables
- + Annualized capital cost of new conventional resources
- + Cost of unspecified energy (market purchases)
- + Net cost of CO2 allowances
- = 2020 Revenue Requirement

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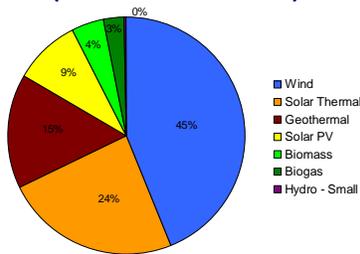


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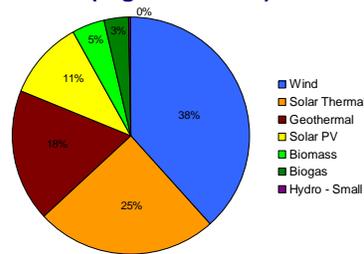
Draft Results from Current Working Model

RES Resource Additions by Type

June 2009 Results
(33% Reference Case)



DRAFT RES Calculator Results
(High Net Short)



Resources Selected by Type	Total	
	MW	GWh
Biogas	279	2,078
Biomass	478	3,346
Geothermal	1,497	11,471
Hydro - Small	40	177
Solar PV	3,235	6,913
Solar Thermal	7,298	17,956
Wind	10,972	32,709
Total	23,798	74,650

Resources Selected by Type	Total	
	MW	GWh
Biogas	279	2,078
Biomass	418	2,931
Geothermal	1,497	11,471
Hydro - Small	40	177
Solar PV	3,145	6,887
Solar Thermal	6,371	15,711
Wind	8,337	24,457
Total	20,087	63,711

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RES Resource Additions by Zone

June 2009 Results (33% Reference Case)

Zones Selected		
	MW	GWh
Total	23,798	74,650
Tehachapi	3,000	8,862
Distributed CPUC Database	525	3,118
Solano	1,000	3,197
Out-of-State Early	2,062	6,617
Imperial North	1,500	9,634
Riverside East	3,000	7,022
Mountain Pass	1,650	4,041
Carizzo North	1,500	3,308
Out-of-State Late	1,934	5,295
Needles	1,200	3,078
Kramer	1,650	4,226
Distributed Biogas	249	1,855
Distributed Geothermal	175	1,344
Fairmont	1,650	5,003
San Bernardino - Lucerne	1,800	5,020
Palm Springs	806	2,711
Baja	97	321

DRAFT RES Calculator Results (High Net Short)

Zones Selected		
	MW	GWh
Total	20,887	63,711
Tehachapi	3,000	8,871
Distributed CPUC Database	675	3,552
Out-of-State Early	2,062	6,617
Imperial North	1,500	9,643
Riverside East	3,000	7,075
Carrizo North	1,500	3,369
Mountain Pass	1,650	4,056
Kramer	1,650	4,260
Distributed Biogas	249	1,855
Out-of-State Late	1,934	5,295
Needles	1,200	3,078
Distributed Geothermal	175	1,344
Fairmont	1,492	4,696
San Bernardino - Lucerne	-	-
Solano	-	-
Palm Springs	-	-
Baja	-	-

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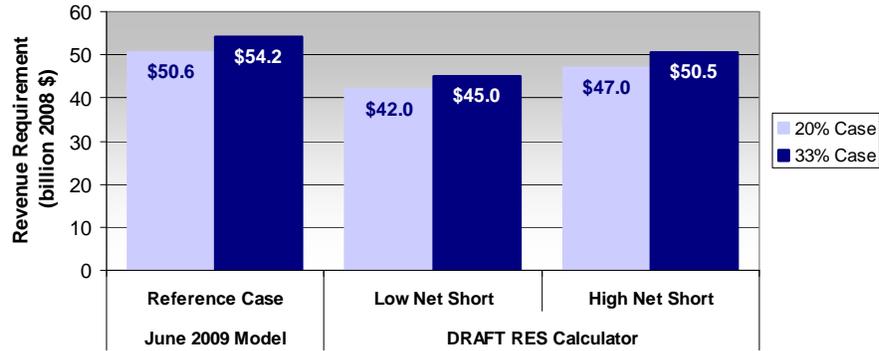
Cost Impacts (DRAFT RES Calculator, High Net Short)

Revenue Requirement Impact (millions of 2008 \$)			
	2020: 20% Reference Case	2020: 33% Reference Case	Change relative to Reference Case
Existing T&D Costs	20,164	20,164	-
Existing Gen Fixed Costs	8,547	8,547	-
New Conventional Fixed Costs	4,255	2,833	(1,421)
Existing and New Conventional Variable Costs	10,956	9,080	(1,876)
Incremental Demand Response Costs	-	-	-
New Renewables Build	2,771	8,458	5,688
New Transmission for Renewables	309	1,458	1,149
Net CO2 Allowance Costs	-	-	-
Total Revenue Requirement	\$47,002	\$50,541	\$3,539
Average Retail Rate (\$/kWh)	\$0.156	\$0.168	\$0.012 (+7.5%)

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2020 Revenue Requirements Under Plausible Compliance Scenarios



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Resource Additions (Low Net Short)

Resources Selected by Type

	In-State		Out-of-State		Total	
	MW	GWh	MW	GWh	MW	GWh
Biogas	279	2,078	-	-	279	2,078
Biomass	241	1,687	87	610	328	2,297
Geothermal	1,264	9,683	58	445	1,322	10,127
Hydro - Small	25	111	15	66	40	177
Solar PV	2,955	6,471	-	-	2,955	6,471
Solar Thermal	5,002	12,372	181	443	5,183	12,815
Wind	3,458	10,281	2,377	6,853	5,836	17,135
Total	13,224	42,682	2,719	8,417	15,943	51,099

Zones Selected

	MW	GWh	Notes
Total	15,943	51,099	
Tehachapi	3,000	8,871	Included in Reference Case
Distributed CPUC Database	675	3,552	Included in Reference Case
Out-of-State Early	2,062	6,617	Included in Reference Case
Imperial North	1,500	9,643	Included in Reference Case
Riverside East	3,000	7,075	
Carizzo North	1,500	3,369	
Mountain Pass	1,650	4,056	
Kramer	1,650	4,260	
Distributed Biogas	249	1,855	
Out-of-State Late	657	1,800	

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Cost Impacts (Low Net Short)

Revenue Requirement Impact (millions of 2008 \$)			
	2020: 20% Reference Case	2020: 33% Reference Case	Change relative to Reference Case
Existing T&D Costs	19,361	19,361	-
Existing Gen Fixed Costs	8,547	8,547	-
New Conventional Fixed Costs	2,675	1,371	(1,304)
Existing and New Conventional Variable Costs	9,226	7,598	(1,629)
Incremental Demand Response Costs	-	-	-
New Renewables Build	1,959	6,951	4,992
New Transmission for Renewables	205	1,219	1,014
Net CO2 Allowance Costs	-	-	-
Total Revenue Requirement	\$41,973	\$45,047	\$3,073
Average Retail Rate (\$/kWh)	\$0.159	\$0.171	\$0.012 (+7.3%)

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